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INSECTS IN RELATION TO POLLINATION OF SOME UMBELLIFERS

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ABSTRACT

Plants and animals constitute the biotic component of every ecosystem. They interact with each other in many ways. Some interactions are synergistic and others antagonistic. But for one the survival of the other group and that of the ecosystem itself gets threatened. One of the areas of interaction between plants and animals is the pollination biology. The entomophilous pollination involves interaction between flowering plants and certain groups of insects. Entomophily has specific requirements, the entomophilous flowers are large, colourful, scented and zygomorphic. All these characteristics draw insects towards flowers and in the process pollination is effected.

INTRODUCTION

Unlike other entomophilous flowers, the umbellifer flower is simple and inconspicuous, yet most of the umbellifers are insect pollinated. On account of the simplicity of their flower and the variety of insects which call at them, Grant (1949) suggested that umbellifers are promiscuously pollinated. However, Bell (1971), Bell and Lindsey (1978) and Lindsey (1984) observed pollinator specificity in some umbellifers. In order to resolve these paradoxes, observations were made on the interaction of the wild and cultivated varieties of carrot *(Daucus carota)* and fennel *(Foeniculum vulgare)* with the insects that pollinate them. The carrot has male and bisexual flowers intermixed in most of its umbels and is therefore, andromonoecious. Fennel is hermaphrodite and all its umbels bear only bisexual flowers.

DISCUSSION

Although like other umbellifers, individual flowers of these taxa as well are inconspicuous, their aggregation in compact umbels creates a strong visual impact (Figs. 1-4). As such, it is the umbel which functions as the "attractive unit" Additionally, carrot and fennel flowers offer such other attractions to insects as the nectar and enormous quantity of pollen.

The quantity of pollen in carrot is 1,024—2,547 ($\overline{X}$ 1,797 ± 101.46) pollen grains per anther for cultivated variety and 1,809—2,190 ($\overline{X}$ 1,983 ± 42.57) for wild one. The range in fennel is higher; 3,510—6,450 (4,802 ± 319.03) in cultivated and 5,596—6,176 (5,854 ± 59.67) in wild subspecies. There are five anthers per flower, numerous flowers per umbel and many umbels per plant (Figs. 1-4). Accordingly, pollen produced per plant is enormous (Table 1). The sequential development of anthers within a flower and of flowers within an umbel staggers pollen production over a long period of time and by so doing ensures insect visits over longer duration.

Another reward which the flowers of

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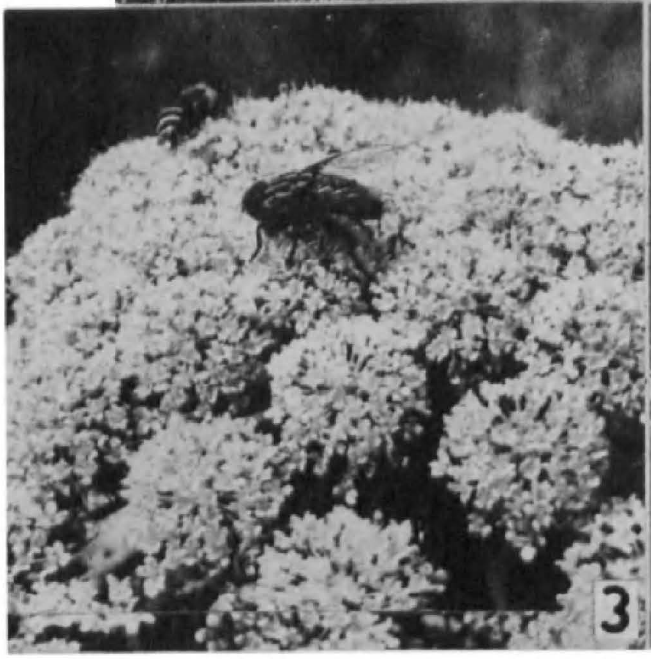

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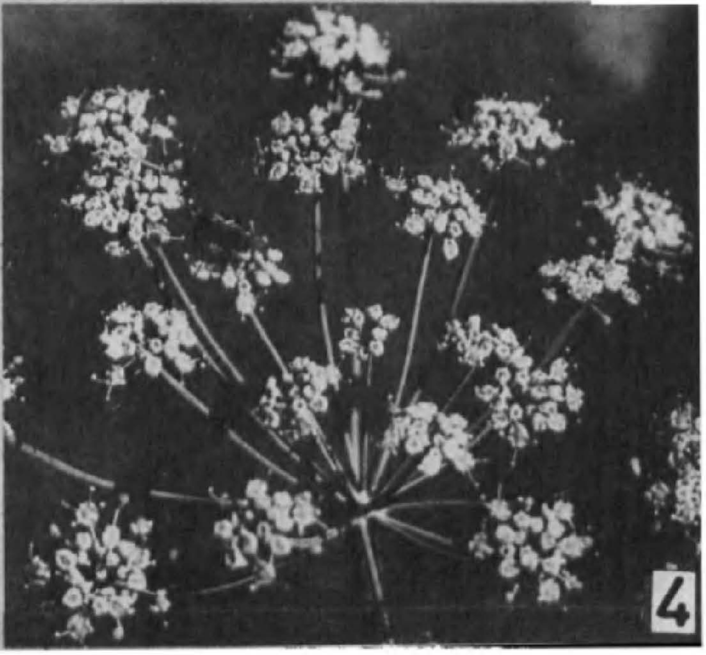

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Figs 1 & 2 Plants of *Daucus carota* (Fig 1) and *Foeniculum vulgare* (Fig 2)

Figs. 3 & 4 Umbels of carrot and fennel respectively Note the presence of pollinators in Fig 3

Table 1. Data on pollen grain production in carrot and fennel

	D. carota ssp. *sativus*	*D. carota* ssp *carota*	*F vulgare* ssp *vulgare*	*F vulgare* ssp. *piperitum*
Anther	1,797 ± 101.46 (1,024–2,547)	1,983±42.57 (1,809–2,190)	4,802±319.03 (3,510–6,450)	5,854±59.67 (5,596–6,176)
Flower	8,985	9,915	24,010	29,270
Plant	86,161,067.95	154,942,992.5	46,345,062	144,269,780

fennel and carrot offer to the visiting insects is the nectar secreted by the bulbous stylopodium. The nectar secretion commences early in the morning and continues up to 14 hrs in case of *Daucus carota* and 14.30 hrs in *Foeniculum vulgare*. The quantity of nectar secreted during the receptive phase of stigma exceeds the quantity secreted during anthesis; against 0.05 µl of nectar secreted by a flower of carrot, for 2 hrs, during anther dehiscence when pollen is also available for insect consumption, the quantity secreted for the same period during the receptive phase of stigma, when pollen is no more available, is 0.07 µl. The difference in the quantity of nectar produced during two developmental phases compensates for the non-availability of pollen during the later stages.

The attractants and rewards which umbels of carrot and fennel offer, invite a variety of insects to them. The cultivated varieties of fennel as well as carrot attract wider variety of insects than do their wild counterparts (Table 2).

The insect visitation is influenced by several environmental factors particularly light and temperature. The frequency of different types of insects on umbels varies on sunny and cloudy days. On the sunny days, dipterans constitute 97.14% of the visitors to umbels of cultivated carrot but on cloudy days, the figure is as low as 39.86%. The frequency of hymenopterans increased from 2.65% on sunny days to 41.22% on cloudy days. In ssp. *carota* (wild carrot), hymenopterans dominate on sunny days but on cloudy days their dominance is challenged by the dipterans. However, the total insect visitation is reduced on cloudy days to umbels of both carrot as well as fennel. So cloudy days, in general, affect insect visitation adversely.

All insect visitors to umbels of carrot and fennel are not pollen carriers. Some appear to collect their reward for no returns to the plant. Of the 39 insect species collected from umbels of carrot, individuals of only 25 carried the relevant pollen on their body; in fennel the actual break-up is 14 out of 18. Insects of different types vary in their efficiency as pollinators. This gets reflected in the quantity of pollen they carry (Table 3).

Based upon the pollen load which the insects carry, hymenopterans are the most efficient pollinators of carrot as well as fennel. The efficiency of hymenopterans as best pollinators had also been reported by Bohart and Nye (1960) and Bell and Lindsey (1978) while working on umbellifers. The coleopteran visitors are least effective. Although they feed on pollen and other floral parts, their smooth, skinning, slippery shell does not let any pollen to stick to their body. Moreover, some of them, particularly the beetles, are sluggish in movement and therefore, they remain restricted to the same individual and worse still to the same umbel. The lepidopterans suck nectar through their long proboscis without touching the anthers and therefore they too do not help in pollination. The bulk of visitors to the umbels of carrot and fennel are the dipterans and hymenopterans. Insects of both these orders visit

Table 2. Insect types collected from umbels of different taxa

	Total number of insect	Diptera	Hymenoptera	Coleoptera	Lepido-ptera	Hemi-ptera
D. carota ssp. *sativus*	34	12	11	5	2	4
D. carota ssp. *carota*	24	9	11	1	2	1
F. vulgare ssp. *vulgare*	14	5	7	1	1	—
F. vulgare ssp. *piperitum*	7	5	2	—	—	—

umbels in search of nectar as well as pollen. The hymenopterans carry greater pollen load than their dipteran counterparts. Barring ants, all other hymenopterans move freely and briskly over as well as between umbels and in the process transfer pollen from flowers of one umbel to those of another, of the same or neighbouring plants.

Table 3. Quantity of pollen grains carried by insects belonging to different orders

Pollen load per insect	Diptera	Hymenoptera	Coleoptera	Lepidoptera	Hemiptera	Total no of insect
Carrot :						
<100	8	5	3	1	1	18
100 – 500	2	3	–	–	–	5
501 – 1000	–	1	–	–	–	1
>1000	–	1	–	–	–	1
Fennel :						
<100	5	1	1	–	–	7
100 – 500	1	4	–	–	–	5
>500	–	2	–	–	–	2

Flowers and umbels of carrot as well as fennel are strongly protandrous; the stigmas become receptive only when all anthers of the umbel have shed pollen. Unlike anther dehiscence which is a prolonged affair, stigmas of all flowers within an umbel become receptive simultaneously. In an individual, umbels of different orders bloom one after the other, with a gap of few days inbetween. Thus, when the primary umbel has reached the stigma receptive phase, flowers belonging to secondary order umbels undergo anthesis. This brings about an overlap of the male and female phases of umbels of different orders. The overlap is more prolonged in carrot than in fennel. Insect activity involving primary and secondary or secondary and tertiary umbels of the same plant lead to geitonogamy. Xenogamy also takes place simultaneously, through the brisk movements of insects between umbels of adjacent plants. As such, irrespective of the differences in their umbel make-up, carrot and fennel practice similar pollination system. The pollination system has not changed even on domestication. Cultivation has, however, intensified the interaction between plants and the pollinating insects probably by improving visual impact or the availability of rewards.

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